Diamond-based biochemical sensors

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Diamond exhibits several special properties, e.g. chemical stability, low background current, and a large electrochemical potential window, which make it particularly suitable for biofunctionalization and biosensing. In this contribution, we present the covalent attachment of enzymes to nanocrystalline diamond thin films. Although immobilized at the surface, the biomolecules are still fully functional and active. Different routes are available for the functionalization of nanocrystalline diamond surfaces depending on the surface termination, hydrogen or oxygen. Hydrogen-terminated nanocrystalline diamond films can be modified using a photochemical process to generate a surface layer of amine groups, to which proteins can be covalently bound in several following steps. For comparison, oxygen-terminated NCD films have been functionalized using different chemical methods. The enzymes catalase and horse-redish peroxidase were immobilized on the modified NCD electrodes, and the successful attachment was confirmed by measuring the enzyme activity. Impedimetric experiments were also used to study the surface modification. The enzyme-modified diamond electrodes exhibit direct electrochemical charge transfer between the enzyme redox center and the electrode. The enzyme-NCD electrodes were also used as H_2O_2 sensors. In the presence of H_2O_2, a large cathodic current is observed due to the reduction of H_2O_2 catalyzed by the enzyme modified electrode.

These results provide important steps towards the realization of diamond-based amperometric biosensors. Considering some of the unique properties of nanocrystalline diamond, such as ease of production, chemical stability, and excellent electrochemical properties, it is justified to speculate that nanocrystalline diamond can play an important role in the future of biosensors.